

**PATENT APPLICATION**

**TRACKING SOLAR SHELTER**

5                                    CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the filing of U.S. Provisional Patent Application Serial No. 60/452,828, entitled "Tracking Solar Array", filed on March 7, 2003, and the specification thereof is incorporated herein by reference.

10                                    BACKGROUND OF THE INVENTION

Field of the Invention (Technical Field):

15                                    The present invention relates to a solar tracking, solar power generating shelter, particularly useful for vehicles.

Description of Related Art:

20                                    Note that the following discussion refers to a number of publications by author(s) and year of publication, and that due to recent publication dates certain publications are not to be considered as prior art vis-a-vis the present invention. Discussion of such publications herein is given for more complete background and is not to be construed as an admission that such publications are prior art for patentability determination purposes.

25                                    Methods and devices for generating electric power using solar tracking panels are known. However, such solar systems are either fixed or are dual tracking. The dual tracking systems are, consequently, limited to being disposed on one vertical support structure and must utilize complex support systems to confer sufficient structural integrity to avoid being affected by adverse natural or man-made forces. They cannot be linked to form larger systems.

For example, U.S. Design Patent No. 408,554 discloses a solar shade system, but it does not track the movement of the sun. Applicant has also constructed a solar carport, but it is distinguishable from the present invention in various regards, including the absence of solar tracking capabilities. U.S. Patent No. 4,995,377 discloses a tracking solar array, but it is dual-axis tracking and cannot be linked to other such devices. U.S. Patent No. 6,058,930 discloses a single-axis tracking device, but it relies on a complex apparatus to lend structural and mechanical integrity and strength. Japanese Patent No. JP2002194912 discloses a solar carport, but it cannot be linked to provide larger area coverage and does not track the sun's movement.

Therefore, solar tracking capacity has not been applied to larger solar array systems. The prior art does not address the need to maximize the use of space dedicated to larger solar power systems and to simultaneously maximize the amount of solar energy that can be collected.

#### BRIEF SUMMARY OF THE INVENTION

The present invention comprises a shelter-providing solar tracking assembly comprising solar power arrays and an inverter to convert energy from direct current to alternating current. Each array comprises solar panels that comprise photovoltaic cells. The solar power arrays are disposed on support structures comprising beams, trusses, and vertical support pillars. The solar power arrays are movable on a single-axis and are connected to a drive mechanism so that they can track the movement of the sun. The solar power arrays form an overhead shelter for items located beneath them. The solar power arrays provide electrical power to a building or structure located near them.

The assembly may comprise a back-up generator, batteries to store generated power, an electric output connector. The assembly may provide a shelter for vehicles located beneath the solar power arrays.

A primary object of the present invention is to provide for portable renewable solar energy while simultaneously providing shelter for vehicles.

5 A primary advantage of the present invention is that it minimizes the need for space to situate a solar power array.

Another advantage of the present invention is that it tracks solar energy so that it maximizes the amount of solar energy that is harnessed.

10 Other objects, advantages and novel features, and further scope of applicability of the present invention will be set forth in part in the detailed description to follow, taken in conjunction with the accompanying drawings, and in part will become apparent to those skilled in the art upon examination of the following, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly  
15 pointed out in the appended claims.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The accompanying drawings, which are incorporated into, and form a part of, the specification,  
20 illustrate one or more embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are only for the purpose of illustrating one or more preferred embodiments of the invention and are not to be construed as limiting the invention. In the drawings:

25 Fig. 1 is a top perspective view of the preferred embodiment of the present invention;

Fig. 2 is a top perspective view of the embodiment of Fig. 1 showing the support structure;

Fig. 3 is a top perspective view of the support pier of the embodiment of Fig. 1;

Fig. 4 is a top perspective view of the rebar structure of the support pier of the embodiment of Fig. 1;

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Fig. 5 is a top perspective view showing the photovoltaic modules of the embodiment of Fig. 1;

Fig. 6 is a top perspective view of the embodiment of Fig. 1 showing the array support tube;

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Fig. 7a shows a perspective view of the rotor bearing assembly of the embodiment of Fig. 1;

Fig. 7b shows a perspective view of the drive assembly of the embodiment of Fig. 1;

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Fig. 8 shows a perspective view of the end coupler tube and array support tube of the embodiment of Fig. 1;

Fig. 9a shows a perspective view of the drive assembly and its support pillar of the embodiment of Fig. 1;

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Fig. 9b shows a perspective view of the drive assembly of the embodiment of Fig. 1;

Fig. 10a shows a perspective view of the rotor bearing assembly and its support pillar of the embodiment of Fig. 1;

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Fig. 10b shows a perspective view of the rotor bearing assembly of the embodiment of Fig. 1;

Fig. 11 shows a bottom perspective view of the solar array support structure of the embodiment of Fig. 1; and

Fig. 12 shows a top perspective view of a solar array panel and supporting truss structure of the embodiment of Fig. 1.

### DETAILED DESCRIPTION OF THE INVENTION

The present invention is a solar tracking, solar power array that provides shelter, particularly for vehicles. The shelter comprises a single-axis solar tracking apparatus and solar panels disposed in such a way that shelter is provided to items disposed beneath the solar panel array such as vehicles (e.g., cars, trucks, etc.) parked beneath the solar panel array. The tracking solar array preferably includes the solar power array assemblies coupled with rotor bearings and drive assemblies that include drive actuators on a torque rotator assembly held by pillars.

This array preferably uses pre-engineered, pre-manufactured solar sections which are made to recognized engineering standards and specifications. The preferred embodiment of the present invention is based on a photovoltaic system operating in a grid-tied configuration.

The preferred embodiment uses a photovoltaic system which is capable of single-axis tracking which will provide the attached building with up to 25% more power than a fixed solar structure. The photovoltaic system preferably utilizes generators to provide for back-up power. In the alternative, storage batteries may be utilized.

Each section of the solar array follows the movements of the sun. Parts of the array can be fixed while other sections track the sun for optimal solar power. The solar array preferably tracks the sun and thereby moves in the direction of the sun so that the maximum energy is produced. The structure may be positioned to track in a North-South orientation or in an East-West orientation. The preferred

tracking system allows the array to follow the sun throughout the day if its longitudinal axis is positioned in a North-South configuration. If the longitudinal axis is positioned in an East-West configuration, the preferred tracking system follows the sun's seasonal movement from north to south.

5           Turning now to the figures, which illustrate the preferred embodiment of the invention, Fig. 1 shows solar tracking vehicle shelter **20** comprising solar array assembly **22**. Solar array assembly **22** comprises solar modules **24**. There are preferably twenty solar modules **24** (of preferably 105 watts each) per solar array assembly **22**. Although three solar array assemblies **22** are depicted in the figures, any number of solar array assemblies **22** may comprise solar tracking shelter **20** as desired.

10       Solar array assemblies **22** are supported by solar array support structure **50** and array support tube **56**, both of which are shown in Fig. 2, which in turn are supported by bearing assembly support pillar **26** and drive assembly support pillar **28**. Support pillars **26**, **28** are supported by, and attached to, piers **30**. Support pillars **26**, **28** and entire solar array support structure **50** are preferably constructed of steel, but may be constructed of any rigid material suitable for the purpose of providing support, and piers **30** are

15       preferably constructed of concrete, but may be constructed of any material sufficient to provide support. Attached to array support tube **56** and support pillar **26** is rotor bearing assembly **34**. Attached to array support tube **56** and support pillar **28** is drive assembly **32**. Preferably, the number of rotor bearing assemblies **34** is equal to the number of solar array assemblies **22**. The solar tracking shelter preferably comprises one drive assembly **32**.

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Fig. 2 shows solar array support structure **50** comprising array support tube **56**, truss assembly **52**, and edge guard **54**. Solar modules **24** attach to solar array support structure **50**. Support structure **50** is preferably constructed of steel, another metal, or other similarly rigid material.

25           Fig. 3 shows pier **30** with attached attachment plate **40**. Fig. 4 shows preferred rebar structure **42** that supports the concrete of which pier **30** is preferably constructed. Attachment plate **40** preferably attaches to pier **30** via J-bolts although other fasteners known in the art may be used.

Fig. 5 is another view showing solar array assembly **22** disposed on truss assembly **52**, rotor bearing assembly **34** disposed on support pillar **26**, drive assembly **34** disposed on drive assembly **28**. Also shown are DC power disconnect **38** and DC to AC power inverter **36**, both preferably disposed on support pillar **26**. Inverter **36** is preferably 2.5 kW.

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Fig. 6 shows array support tube **56** connected to drive assembly **32** and rotor bearing assembly **34**. Also shown is tracking drive mechanism **48** disposed on support pillar **28**. Drive assembly **32** comprises a drive actuator assembly that is preferably grid-tied to solar array assembly **22** and to generators (not shown), if utilized, for controlling movement of solar array assembly **22**. In the preferred embodiment, drive assembly **32** is controlled by drive mechanism **48**.

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Fig. 7a is an exploded view of rotor bearing assembly **34**. Disposed on mounting plate **44** of support pillar **26** is mounting bracket **67** which in turn holds bearing housing **62**. Bearing housing **62** is disposed within sleeve bearing **60**. Within bearing housing **62** turns coupler tube **64**. Coupler tube **64** also turns within end coupler torque tube **66** which is fixed onto end plate **68** of array support tube **56**.

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Fig. 7b is an exploded view of drive assembly **32**. Disposed on mounting plate **47** of support pillar **28** is base plate **80**. Disposed on base plate **80** is face plate **73** to which coupler tube **70** and coupler plate **74** are disposed. Coupler tube **70** turns within end coupler torque tube **66**.

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Fig. 8 is an exploded view of end coupler torque tube **66** fixed onto end plate **68** of array support tube **64**.

Fig. 9a is another view showing drive assembly **32** disposed via base plate **80** to support pillar **28**. Support pillar **28** is attached via pillar attachment plate **45** to attachment plate **40** of pier **30**. Fig. 9b is an exploded view of drive assembly **34**. Base plate **80** is attached to mounting plate **47**. Face plate **73** is attached to base plate **80**. Coupler tube **70** turns within face plate **73**. Shroud **72** surrounds coupler plate **74**. Also shown are spacers **76** which attaché back angle supports **78** to face plate **73**.

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Fig. 10a is another view of rotor bearing assembly **34** attached to support pillar **26** which attaches to attachment plate **40** of pier **30** via pillar attachment plate **49**. Also shown are inverter **36** and DC disconnect **38**. Fig. 10b shows mounting bracket **67** attached to mounting plate **44**. Attached to mounting bracket **67** is sleeve bearing **60** which houses bearing housing **62**. Within bearing housing **62** turns coupler tube **64**. Fasteners **63** fasten coupler tube to end coupler torque tube **66**.

In the preferred embodiment, each solar array assembly **22** is disposed on one solar array support structure **50** with one array support tube **56**. Array support tubes **56** may be linked together via end coupler tube **66** of array support tube **56** and coupler tube **64** of rotor bearing assembly **34** and/or coupler tube **70** of drive assembly **32**. Therefore, any number of solar array assemblies may be linked to form any size solar tracking structure **20**. Solar array assembly **22** may therefore be assembled off-site then linked to other solar array assemblies **22** on-site as desired.

Fig. 11 shows the underside of solar array support structure **50**. Truss assembly **52** comprising angle strut **100**, mounting rail **102**, and mounting clamp **104** is shown. Edge guard support **54** is also shown. Solar array assembly **22** attaches to mounting rail **102** and edge guard support **54**. Truss assembly **52** attaches to array support tube via mounting claim **104**. Also shown in Fig. 11 are electrical junction box **82** and electrical conduit **84** preferably incorporated into solar tracking vehicle shelter **20** to conduct the solar power into a building electrical interface box or other interface (e.g., remote or attached, not shown) so that a nearby building or structure may utilize the solar power from solar tracking vehicle shelter **20**.

Fig. 12 is an exploded view of solar modules **24** comprising frames **90** disposed on truss assembly **52** via mounting rail **102**. Angle strut **100** and mounting claim **104** attach to array support tube with the aid of clamp fasteners **106**.



Also a part of solar tracking vehicle shelter **20** are appropriate disconnects (not shown), safety switches (not shown) and combiner boxes (not shown) for each solar array assembly **22**. Any number of solar modules **24** may be utilized. Likewise, different wattages for the components may be utilized.

5           Smaller, individualized inverters **36** minimize the impact of inverter failure on solar array assembly **22** and are easily replaced. The energy produced from the solar array assembly **22** is transferred to an electrical interface box (not shown) in a nearby building or structure.

10           Generators (not shown), if utilized, are preferably two generators (e.g., 60kW), one generator e.g., 20kW) and transfer switches (e.g., three) per solar array assembly **22**. Solar array assembly **22** preferably has pre-manufactured cells, but the structure of the array is built on-site and preferably includes a building electrical interphase such as electrical junction box **82**.

15           Solar tracking vehicle shelter **20** is preferably used as a carport, but may alternatively be used as a shelter for any purpose such as, for example, a weather structure, a porch, or similar structure. Solar array assembly **22** protects and shields the items in the spaces under solar array assembly **22** while providing energy to the attached or nearby building or structure. If solar tracking vehicle shelter **20** is used as a carport, each solar array assembly **22** may accommodate up to two full-sized vehicles.

20           In other alternative embodiments solar tracking vehicle shelter **20** may include optional solar array assembly **22** or more generators.

#### Example

25           A solar tracking carport was constructed in accordance with the present invention. There were included twenty Photowatt PW 1250 PV modules per solar array assembly, a 600 Vdc DC disconnect with enclosure per solar array assembly, one 2.5kW inverter per solar array assembly, a single-axis tracking array apparatus, an AC service panel with enclosure, an AC/Utility main disconnect, 125 watt photovoltaic modules, and disconnects, safety switches and combiner boxes for each section.

Each solar array assembly measured approximately 24 feet in length, approximately 12 feet in width, and the bottom edge of each array rose approximately 8 feet, 6 inches in height off the ground.

5           Although the invention has been described in detail with particular reference to these preferred embodiments, other embodiments can achieve the same results. Variations and modifications of the present invention will be obvious to those skilled in the art and it is intended to cover in the appended claims all such modifications and equivalents. The entire disclosures of all references, applications, patents, and publications cited above are hereby incorporated by reference.